COMPANION GUIDE 4

Chemical: inorganic sites

Responsible Care

CHEMICAL INDUSTRIES ASSOCIATION

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

BEST PRACTICE PROGRAMME

COMPANION GUIDE 4

RESPONSIBLE ENERGY AND THE ENERGY EFFICIENCY BEST PRACTICE PROGRAMME

By improving energy efficiency, companies:

- Save money.
- Improve profitability.
- Sharpen competitiveness.
- Reduce emissions levels, helping protect the environment.

The UK chemical industries and the Government are collaborating on the Responsible Energy initiative – as part of the chemical industries' international Responsible Care programme for continuous improvement in health, safety and the environment.

Responsible Energy brings together the Chemical Industries Association (CIA) and the Government. This partnership has developed the CASCADE series of publications, to help you use the wealth of practical information available in Energy Efficiency Best Practice Programme (EEBPP) literature.

Using the EEBPP will help you save energy quickly and cost-effectively.

This document was prepared for the Government by ETSU. We wish to thank Linnhoff March, the CIA, IChemE, and the many chemical companies who contributed to the development and production of this publication.

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ABOUT THIS COMPANION GUIDE

This Companion Guide has been designed to help companies who manufacture bulk inorganic chemicals to identify and exploit their opportunities for energy savings. Energy typically represents 5 - 15% of total manufacturing costs for inorganic chemicals, though there are examples where energy is an even higher proportion of basic costs – for example, the chloralkali industry. The inorganic chemicals industry spends about £200 Million per annum on energy and on average around 10% of this could be saved, which represents a substantial contribution to companies' bottom line profits. This Guide will help your company reduce its energy consumption, so lowering its manufacturing costs and raising its competitiveness. Good practice in energy use is good business practice: it will help your company satisfy environmental regulatory standards. The Climate Change Levy makes action on saving energy even more important.

This Guide is to be used in conjunction with the Chemical Industries ***Pathfinder*** Guide designed for the chemical industry as a whole. It contains summary information on broad areas of energy savings measures and a full list of EEBPP literature relevant to chemical companies. Copies of the ***Pathfinder*** can be obtained FREE from the Environment and Energy Helpline on 0800 585794, along with any other EEBPP publications required. Further advice on energy savings topics or on good environmental practice is also available through the Helpline.

This Companion Guide is divided into two sections

CONTEXT

This outlines the reasons why energy efficiency remains a vital issue to companies manufacturing bulk inorganic chemicals. It considers the steps that should be taken to manage energy efficiently and effectively and to establish a sound improvement programme. It also summarises the way energy is used within the sector. Typical plant and utility requirements to meet processing needs are briefly described.

KEY OPPORTUNITIES TO SAVE ENERGY

Opportunities are explored over the range of technologies and management techniques commonly used in the inorganic sector. This section identifies key publications detailing how energy can be saved and how your peer companies have in many cases already been successful. The topics in this section have been identified with the help of expert consultants working with the inorganic chemicals subsector.

In today's competitive world, all companies need to manage every aspect of production costs and energy is one of those costs that can be readily brought under control. With the CIA's existing voluntary Agreement on Energy Efficiency, the new Climate Change Levy and the need to satisfy the EU's Integrated Pollution Prevention and Control Directive, effective and efficient use of energy is now more important than ever. By acting upon the advice given in this companion Guide and the other excellent and free publications from the Government's Energy Efficiency Best Practice Programme, manufacturers of inorganic chemicals can better manage their energy use. Saving energy not only makes good business sense and helps our industry satisfy its commitment under Responsible Care, but also produces a better environment for our stakeholders and helps to secure the future environment for future generations.

President of CIA

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PART I - *CONTEXT*

WHY ENERGY EFFICIENCY IS STILL IMPORTANT FOR INORGANIC CHEMICAL COMPANIES

Many UK inorganic chemical companies have already done a great deal to improve energy efficiency and reduce costs. Experience has shown that scope remains for all companies to make further improvements. Continuous improvement in energy efficiency is part of the chemical industries' commitment to Responsible Care. Companies should consider:

- How much they are doing compared to competitors?
- How much more they can do?
- What are the costs and the benefits?

ENERGY MANAGEMENT IS GOOD BUSINESS MANAGEMENT

An energy management programme can:

- Reduce operating costs.
- Reduce maintenance costs.
- Reduce capital costs for new plant.
- Improve environmental performance.
- Involve only modest capital outlay.

PLANNING FOR ENERGY EFFICIENCY

- Find out where you are now.
- Decide where you want to be and when you want to get there.
- Decide the best route to get you there on time.

FINDING OUT WHERE YOU ARE NOW

The first step is to monitor the energy use on your site. Remember the old adage –

> *"You can't control it, if you don't measure it"*.

Once monitoring is underway, you can start relating energy use to production patterns.

DECIDING WHERE YOU WANT TO BE

Energy performance – energy use monitored against production patterns – can be used to compare your organisation's performance with industry norms. This is 'benchmarking' and will reveal how far you have to go to achieve first class performance. The three main types of benchmark are:

- Internal – how does your present performance compare against your best performance?
- Theoretical – how does your performance compare against known design parameters for processes, products and equipment?
- External – how does your performance compare with other similar companies?

DECIDING HOW TO GET THERE

When planning an energy management strategy:

- Make sure that all planned energy management activities take into account future expansion and development.
- Remember that measures requiring the lowest initial capital investment are not always the best in the long-term.
- Involve as many key decision makers as possible.
- Consider the level of expertise of the workforce – experience has shown that technology by itself will not reduce energy use, as people have an essential role in driving forward technological improvements.
- Gain top management support and commitment for all energy activities.

CONTEXT

MEASURE ENERGY USE

Adopting a systematic approach to energy management is likely to pay dividends. This guide looks at the individual areas of activity typically found in inorganic chemical production and suggests ways that energy consumption can be reduced in each case. However, action in individual areas will always be more effective when integrated into a site-wide plan.

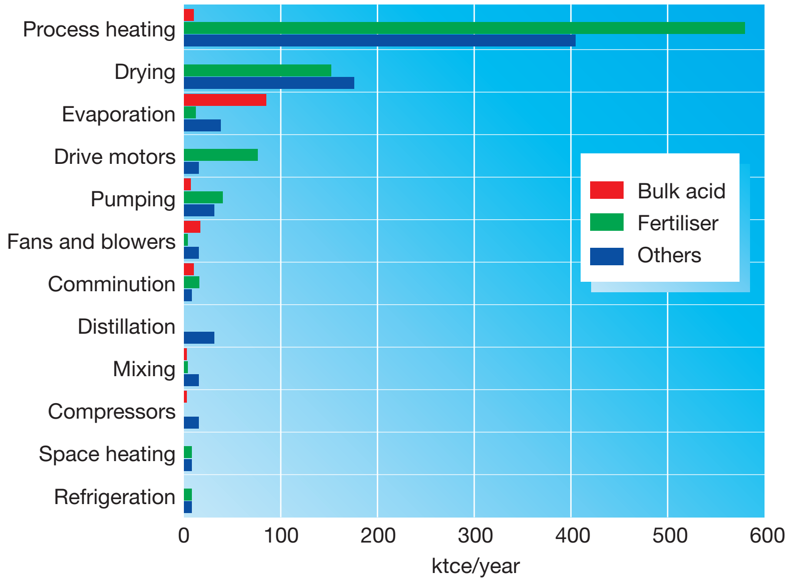
SHORT PAYBACK PERIOD

Many companies that have installed systems to monitor energy use in detail have achieved pay back of the installation costs in months. Good Practice Case Study 330 shows how BP Chemicals approached energy monitoring.

Selected Publications.
Chemical industries pathfinder.
GPCS 330 ***A comprehensive energy management system at a large process site.***

ENERGY USE IN INORGANIC CHEMICAL MANUFACTURING SITES

The figure below shows the energy usage in organic chemical production.



Energy usage based on ED/51

CONTEXT

ENERGY CONSUMPTION BENCHMARKS

'At Huddersfield, we used the Energy Management Matrix to show where we needed to improve, and to subsequently demonstrate that we had achieved that improvement.'

David Lloyd, former Works Energy Manager Astra Zeneca Ltd

You should aim to get as close as possible to the 'benchmark' specific energy consumption which represents a realistic minimum for your operation. To do this, you need to determine the appropriate benchmark. The three types of benchmark identified earlier are:

INTERNAL BENCHMARKS

Use your best specific energy performance as a target for each year, by building up a database of historical energy performance and influencing factors such as external temperature, product type, plant utilisation, etc. Internal benchmarks help you get the best energy performance out of existing plant. Internal benchmarks do not directly identify inefficiencies due to older equipment or poor plant design. Page 7 of the Pathfinder will signpost you towards publications to help you set internal benchmarks, and case histories on their benefits to other companies.

THEORETICAL PROCESS BENCHMARKS

Absolute minimum energy requirements for every reaction are based on thermodynamics and cannot be changed. In practice, the thermodynamic minimum can never be achieved in any process. The process benchmark will always be higher than the theoretical minimum.

'The Energy Management Matrix has been a key part of our review of energy management practice focusing attention on energy policy, improvement objectives, training, publicity and transfer of best practice.'

Simon Pain
Formerly International SHE Coordinator, ICI plc

Theoretical minima for every process required can be based on empirical observations of the processes. You can normally get a good idea of the state-of-the-art in the manufacture of particular products from industry literature or from process engineering consultants and equipment suppliers. This may identify cost-effective retrofit modifications. Although it is seldom cost-effective to replace existing process or utility plant with new technology until close to the end of its operating life, it is worthwhile reviewing your options periodically to determine if new opportunities are available.

EXTERNAL BENCHMARKS

It is difficult to compare sites, and to define common benchmarks – there is no such thing as a 'typical' large site, because of the range of products, processes, and specific conditions. The Chemical Industries Association and the EEBPP are currently exploring ways of producing practical standards.

ORGANISATIONAL BENCHMARKS

Pages 4 to 7 of the chemical industries pathfinder gives a summary of general management and organisational matters. The Energy Management Matrix helps you produce internal and external benchmarks, and assess your current standard. Companies such as ICI and Astra Zeneca Ltd have used the Matrix to highlight where to concentrate their efforts to get the most out of people and plant.

CONTEXT

LOW COST AND MAJOR IMPROVEMENTS

A balanced energy management plan will blend measures and major capital to suit your company's circumstances. Few companies have large reserves of capital to commit to energy efficiency, but you can still save energy through low cost measures.

LOW COST

Up to 20% of your site energy might be wasted through poorly controlled utilities such as cooling water, compressed air, steam and nitrogen which can be avoided through simple 'good housekeeping' measures. For example, by identifying and fixing leaks, sticking valves and steam traps, burner or boiler inefficiency, poor insulation, supply not matched to demand, and pumps and fans left running, significant savings can be achieved at little cost. Pages 4 to 11 of the Pathfinder cover a range of 'people' and operating efficiency measures.

- Make it clear that the whole organisation is committed from the top down to saving energy.
- Maintain momentum by incentives and report successes, to keep energy on the agenda as other priorities arise.

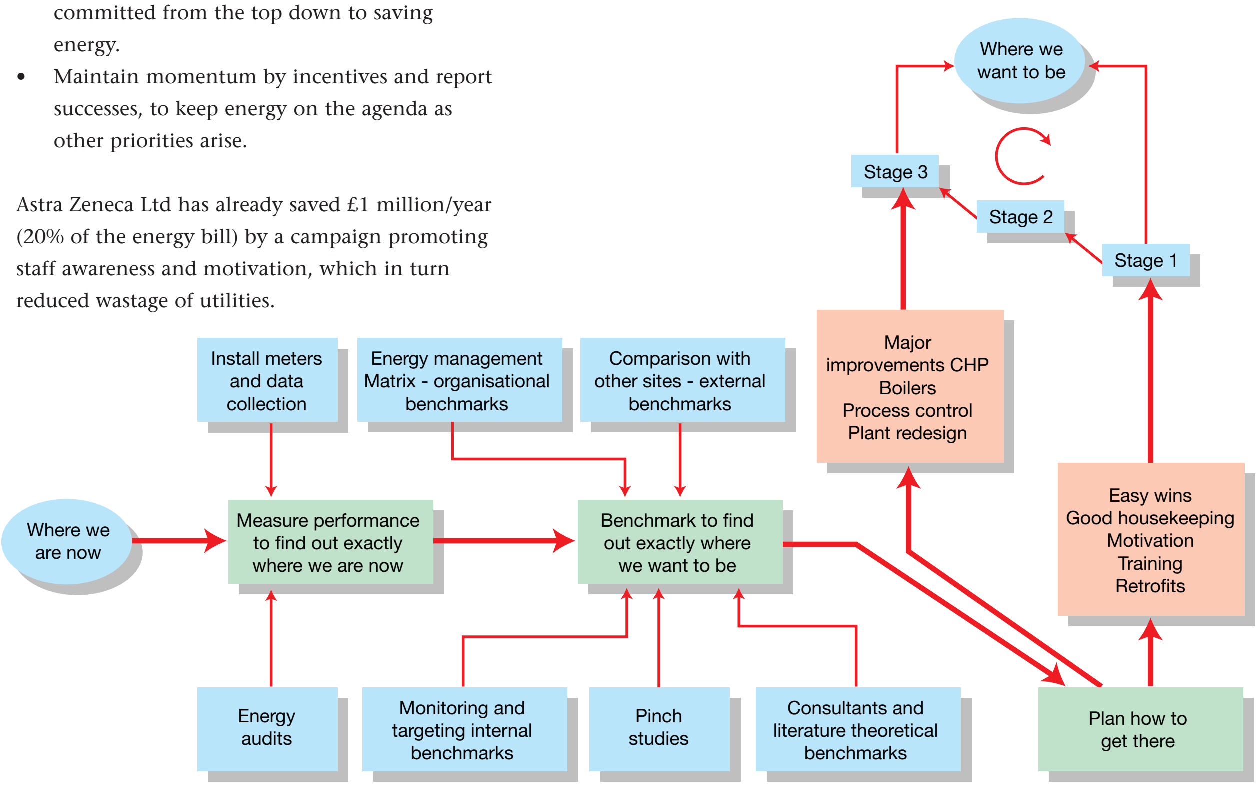
Astra Zeneca Ltd has already saved £1 million/year (20% of the energy bill) by a campaign promoting staff awareness and motivation, which in turn reduced wastage of utilities.

MAJOR IMPROVEMENTS

Energy efficiency measures are can be low on the list of priorities facing companies.

Energy efficiency is not in competition with other activities, but should be an integral part of planning. The additional capital cost of choosing energy efficient options at the design stage can be low compared to the benefits. Pages 12 and 13 of the Pathfinder signpost publications to help you build energy into capital decisions.

Most design decisions usually involve choosing between possible process routes. For example, reduce total NO_x emissions either by installing low NO_x burners or by improving heat recovery to reduce the total fuel consumed. The second option would possibly have a higher capital cost, but would result in operational cost savings.



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PART II - *KEY OPPORTUNITIES TO SAVE ENERGY*

MOTIVATION AND TRAINING

The best energy management plan can only realise energy savings if the staff who are required to implement the plan are motivated and have the training necessary to take energy saving actions.

- Make sure that staff place the right priority on energy efficiency, by showing a clear lead and commitment from the top.
- Think about making energy efficiency part of job objectives, setting incentives for people or sections to save energy, and formal National Vocational Qualifications.
- Monitor and communicate energy usage and progress towards set targets, through an energy newsletter and energy notice boards. Pages 4 to 7 of the Pathfinder give an introduction to Policy and Motivating and Training Staff.

A formally assigned 'energy champion' can often stimulate more savings because he or she:

- Has direct responsibility for setting objectives and monitoring progress against targets.
- Provides a central point for co-ordinating projects and ideas.
- Can step back and look at the whole picture.

GPCS 165 – Astra Zeneca Ltd formerly ICI Fine Chemicals Manufacturing appointed a full-time energy manager, and established and trained a team of part time resource co-ordinators. The energy manager was central to the success of the project, by providing training and support to the resource co-ordinators. Savings of over £500,000/year were achieved at a total cost of £100,000 (1992 prices) for training, staff, metering and revenue expenditure on repairs and minor improvements. Training was a key factor even though it accounted for a small part of total costs. Since the case study, savings from the programme have increased to an estimated £1 million/year.

Selected Publications.

GPG 84 *Motivating staff to save energy.*
GPG 85 *Energy efficiency training.*
GPCS 165 *Energy management and training at Astra Zeneca Ltd.*
Chemical industries pathfinder –
Pages 4 to 7.

KEY OPPORTUNITIES TO SAVE ENERGY

PROCESS AND UTILITIES OPPORTUNITIES

1. STEAM GENERATION AND DISTRIBUTION

Optimising steam systems can provide the best opportunity to make low-cost, energy savings. Attention is often focused totally on production and, as a result, inefficiencies gradually creep into other areas.

Many sites have complex steam systems running at a range of pressures, making balancing supply and demand profiles difficult. For example, individual processes and product streams may well use high pressure steam, but export a much larger quantity of lower pressure steam. In such cases, it may be necessary to vent low pressure steam.

Small local modifications to the steam system occur frequently in response to changes in processes, or to replace items of obsolete or failed plant. Many years may pass between reviews of site-wide steam systems and changes in site operation and production developments can have significantly altered steam demand profiles. Consequently, it is necessary to keep steam generation and distribution under regular review by considering:

- How many steam levels are actually needed?
- What pressure should they be?
- Is combined heat and power (CHP or cogeneration) an option?

The answers should lead to reduced generation and distribution costs and may save capital resources in the medium- to long-term. Consider using simulation software to help to explore some of the issues as this enables an analysis of the site as a whole. Identify any bottlenecks and inefficiencies. Quantify the effect that energy saving projects, plant development and utility projects will have on site steam balance.

Energy Consumption Guide 66 *Steam generation costs* presents the norms for boiler performance based upon UK-wide test results. The guide facilitates a rapid benchmarking of boiler costs and details recommendations for subsequent improvements.

Energy Consumption Guide 67 *Steam distribution costs* will help you to evaluate the cost of steam at its point of use, that is, after distribution losses have been taken into account. This analysis will enable you to assess where gains can be achieved by rationalising your steam distribution system. Possible areas for saving lie in:

- Eliminating obsolescent pipework by consolidating medium and low pressure usage and reducing the length of duplicated pipe runs.
- Improving metering to production areas and eliminating ring mains.
- Eliminating high pressure steam mains by substituting hot oil for high pressure steam usage, especially when the users are remote from the boilers.
- Returning all steam condensate to the boilers.
- Re-examining the case for eliminating central boilerhouses by installing local boilers (this is generally feasible only on large sites).

Carry out a cost analysis in boiler and steam systems to alert you to any defects in existing plant and indicate the benefits from improvements. You may have expertise in-house for this analysis, otherwise call in consultants.

Selected Publications.

ECG 66	***Steam generation costs.***
ECG 67	***Steam distribution costs.***
GPCS 134	***Decentralisation of steam supply on a small industrial site.***
GPCS 352	***Improved turndown and fuel saving on a coal fired boiler using chain grate stokers.***
GPG 18	***Reducing energy consumption by steam metering.***
GPG 30	***Energy efficient operation of industrial boiler plant.***
GPG 88	***Energy efficient use of boilers using chain grate stokers.***
GPG 197	***Energy efficient heat distribution.***
FEB 14	***Economic use of oil-fired boiler plant.***
FEB 15	***Economic use of gas-fired boiler plant.***
FEB 17	***Economic use of coal-fired boiler plant.***

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KEY OPPORTUNITIES TO SAVE ENERGY

2. COOLING AND REFRIGERATION

COOLING

Excess heat loads supplied to manufacturing plant have to be removed by a cooling system. Inorganic chemical processing sites usually have substantial cooling and refrigeration systems.

Optimising energy use involves three basic steps:

- Rationalising the opportunities for reducing the use of process heat.
- Revising the cooling load once the new heat load has been determined.
- Determining the lowest cost provision.

The cooling system has to cater for maximum production in summer conditions and, once installed, there is a tendency for the system to become accepted as a fixed part of the plant. In fact, there is usually plenty of scope to review and re-vamp the overall cooling systems to take into account:

- Changes to production schedules.
- Seasonal factors.
- Improvements to refrigeration and other cooling plant.
- Opportunities to reduce the cooling load by exchange of heat elsewhere in the plant.

Cooling towers and refrigeration systems can become neglected. Regular maintenance is required to ensure optimum performance.

Cooling is normally accomplished by pumping a cold fluid through one side of a purpose-built heat exchanger or into jackets and coils provided on vessels. Most plants have cooling available in alternative forms, so it makes sense to select the simplest and lowest cost form of cooling available. Availability and the temperature difference usually determine the selection of the cooling medium for each application.

Selected Publications.
GPG 225 ***Cooling water systems.***

KEY OPPORTUNITIES TO SAVE ENERGY

REFRIGERATION

Studies have shown that energy savings of up to 25% can be achieved without major capital investment.

Inorganic chemical sites often require cooling water at very low temperatures. Standard cooling water systems cannot generally achieve water temperatures much below 20°C during the summer. Therefore, compressor-based refrigeration plant may have to be used. Such plant can use up to 20% more energy than needed.

The key steps to minimise and optimise refrigeration plant energy use are:

- Use free cooling from cooling tower systems in winter.
- Optimise cooling water circuit demand and distribution.
- Improve maintenance of compressor internals, condenser heat exchangers and expansion valves.
- Replace refrigeration cycle heat exchangers with compact types to improve coefficient of performance.
- Replace expansion valves with units of more appropriate size and performance;
- Improve control and sequencing of refrigeration compressors to match actual process demand.
- Design system modifications to employ multistage cooling, different refrigerants and heat recovery.
- Install higher efficiency motors and variable speed drive systems.

Selected Publications.

GPCS 22	***Use of larger condensers to improve refrigeration efficiency.***
GPCS 76	***Refrigeration fault diagnosis system.***
GPG 59	***Energy efficient design and operation of refrigeration compressors.***
GPG 178	***Cutting the cost of refrigerant leakage.***
GPG 236	***Refrigeration efficiency investment putting together a persuasive case.***
FEB 11	***The economic use of refrigeration plant.***

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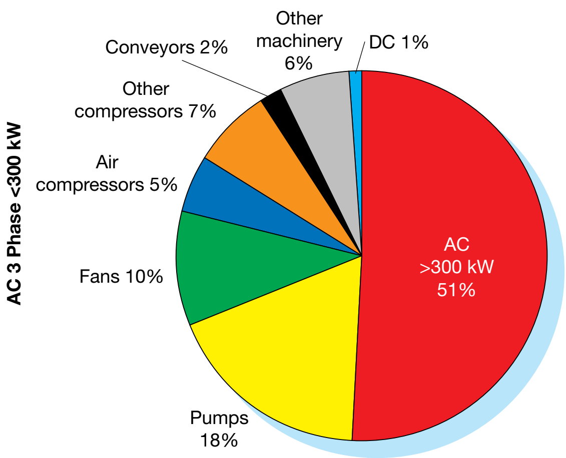
KEY OPPORTUNITIES TO SAVE ENERGY

3. ELECTRICITY – MOTORS AND DRIVES

Electricity is used mainly to drive rotating machinery and for electrolysis. It is an expensive form of energy and should only be used when no other suitable form of energy is available. However, electricity use can be relatively easily measured and controlled.

Around 60% of all the electricity used in the UK chemical industry is for electric motors. Typically, motors run at between 40 and 80% of full rating and are often left running when not needed. The main energy efficiency opportunities in electric motors and drives are:

- Switching off motors when not needed – either manually or with sequence controllers.
- Correctly matching motor sizes to demand profiles.
- Installing variable speed drives (VSDs) – electromechanical or solid state electronic.
- Installing multiple speed motors.
- Installing higher efficiency motors.
- Converting delta to star windings for permanently under-loaded motors.



VSDs have improved considerably in the last few years and safe, reliable units are now available at relatively low cost. Retrofitting VSDs can give a short payback where processes operate with a large turndown. For example, an oil refining company recently saved over £28,000/year by fitting VSDs to two 169 kW fan motors – a simple payback of under two years.

Higher efficiency motor (HEM) designs can give savings of up to 6% over standard models and are now available at the same price as standard motors. While it is not usually cost-effective to replace existing working motors, unless where motors need rewinding, major plant refurbishment programmes provide excellent opportunities for fitting HEMs.

Selected Publications.

GPCS 170	***Variable speed drives in a chemical plant.***
GPCS 222	***Purchasing policy for higher efficiency motors.***
GPCS 300	***Energy savings by reducing the size of a pump impeller.***
GPCS 337	***Low cost speed reduction by changing pulley size.***
GPG 2	***Reducing energy consumption costs of electric motor and drive systems.***
GPG 14	***Retrofitting AC variable speed drives.***

KEY OPPORTUNITIES TO SAVE ENERGY

4. COMPRESSED AIR AND VACUUM

Large quantities of compressed air are used for processes such as feedstock, or as a drying medium. Compressed air is also used for instrumentation, operating pneumatic equipment and for specialised purposes such as the transfer of corrosive liquids. Compressed air costs around 50p/kWh to generate and its use should be carefully controlled.

Compressed air is usually generated centrally and distributed via networks of pipes and valves, and at different pressures and qualities. Systems are often neglected, with over 30% of total energy wasted because of pressure drops, system leaks and inefficiencies in generation and treatment. The energy used to generate and distribute compressed air can be reduced by:

- Immediately identifying and repairing leaks.
- Reviewing existing compressors and their associated control schemes.
- Substituting electrical drives for valve operation, tank mixing, pumping and similar applications.

Consumption is seldom monitored at point-of-use and as a result, production and distribution costs are not attributed to specific activities and simply considered as unavoidable overheads. This gives rise to the attitude that compressed air is 'free' and leads to much of the waste. There are savings to be made in the generation and distribution of compressed air, so start by checking whether the air main could be run at lower pressure and/or quality. Don't forget that enhancement can always be provided locally where higher pressure and/or quality are required.

Carry out a simple system audit by looking at individual applications and asking:

- Is compressed air needed in this case or is an alternative, cheaper form of power available?
- If compressed air is needed, what pressure and quality of air is needed in each case?

Selected Publications.

GPCS 136	***Cost and energy savings achieved by improvements to a compressed air system.***
GPCS 233	***Energy and cost savings from air compressor replacement.***
GPCS 277	***Refurbishment of a compressed air system.***
GPG 83	***Energy efficient liquid ring pump installations in the paper industry.***
ECG 40	***Compressing air costs – generation.***
ECG 41	***Compressing air costs – leakage.***
ECG 42	***Compressing air costs – treatment.***
GPG 125	***Compressing air costs.***
GPG 238	***Heat recovery from air compressors.***
FEB 4	***Compressed air and energy use.***

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KEY OPPORTUNITIES TO SAVE ENERGY

5. DRYING

Drying is often the final step in manufacture, and drying operations consume around 18% of the total energy supplied to the industry. Air is the most common drying medium – typical examples of dryers which use air are rotary, fluidised bed and spray dryers. Other types of dryers, such as belt dryers, are known as direct dryers, as they depend on heat directly transferred from a surface.

Equipment manufacturers has been focused on reducing drying times, which are mainly a function of particle size. However, companies can improve and rationalise existing equipment by:

- Maximising mechanical methods of pre-drying, such as filtration.
- Reducing air usage in fluid bed dryers.
- Scrapping tray dryers and other obsolete equipment.

It is worthwhile carrying out an energy audit on all dryers to:

- Measure the performance of the individual dryers in detail.
- Identify any variations in performance.
- Determine the operating cost per weight of product dried.

This exercise allows individual dryer performance to be benchmarked against industry norms.

Selected Publications.

GPCS 304 ***Point of use heating on a spray drier.***

GPCS 323 ***Adopting a practical, low cost approach to energy efficiency in drying plant.***

NPCS 104 ***Benefits of advanced controls for industrial drying processes.***

GPG 66 ***Rotary drying in the chemical industry.***

GPG 185 ***Spray drying.***

KEY OPPORTUNITIES TO SAVE ENERGY

6. EVAPORATION

Evaporator systems are usually based on three evaporator types:

- Simple kettles, where evaporation and separation is carried out in one vessel.
- Forced convection.
- Film evaporation.

For applications where precipitates are formed, forced circulation systems with an external calandria and a vapour liquid separator are used.

There are good opportunities for improvement to evaporation systems by making the best use of the latent heat in the vapour exported from the plant.

The table gives an indication of the benefits gained by adding effects with and without thermal recompression.

'High pressure evaporator on inorganic chemical duty.'

Table – Benefits of Adding Effects

Type of evaporator	kg steam/kg evaporated
Single effect	1.10 – 1.30
Double effect	0.55 – 0.70
Double effect with thermo compression	0.33 – 0.45
Triple effect	0.37 – 0.45
Four effects, thermo compression across two	0.13 – 0.18
Five effect	0.33 – 0.25
Seven effect, thermo compression across three	0.085 – 0.095

Energy Efficiency Improvement 1 – Adding Effects

Key points

- Further stages ('effects') can be added so that the evaporators work in series (up to seven can be added).
- The working pressure of each vessel in the series is slightly lower than its predecessor.
- The process reduces the boiling point of the solution and enables the vapour driven off from the first evaporator to be re-used to heat the second, and so on.
- Thermo-compression (TVR) using steam jets on one or more of the effects further reduces energy usage.

(see NPFP 70 Plate evaporator for process industries)

Selected Publications.

NPFP 70 ***Plate evaporator for process industries.***

Energy Efficiency Improvement 2 – Mechanical vapour re-compression (MVR)

Key points

- If the vapour from an evaporator is compressed mechanically its temperature rises enabling it to supplied to the evaporator as a heating medium.
- Systems use an electrically driven compressor to compress evaporated vapour.
- The technique is generally the most energy effective solution to evaporation since none of the latent heat in the vapour need be lost to the cooling utility by condensation.
- This is especially valid for water removal because the latent heat of steam is high and large proportion of the total heat content.
- As the cost of an MVR system is higher than a TVR unit on similar duties and power is more expensive than steam, the total cost of a system has to be evaluated for each case.

KEY OPPORTUNITIES TO SAVE ENERGY

7. SOLIDS HANDLING

Many companies have not exploited the potential for energy savings in this area. However, there are items of plant and equipment that can be operated more efficiently.

Both mechanical equipment, such as bucket elevators, screw and belt conveyors, and pneumatic plant, such as conveyors, are commonly used. Design of the conveying equipment was based on grain handling experience, thus information on conveying and elevating in GPG 212 *Reducing energy costs in flour milling* can also be applied for inorganic powder applications.

In terms of energy and operating costs, mechanical conveyors generally offer the best chance for improving energy performance. Energy is wasted by running conveyors when not needed; therefore, control systems should be fitted.

Screw conveyors and mixers for solids need starter motors sized for heavy starting loads to overcome initial friction. However, after the first few seconds of operation, beds of solid particles aerate and the power required is significantly reduced. In recent years, 'soft-start' electric motors and energy saving motor controllers have been developed to give improved motor starting characteristics and better motor performance under varying loads and speeds. Such modern soft-start motor controllers are also suitable for bucket elevators that require high starting loads.

Such improvements can usefully be applied to powder mixers and screw conveyors fitted with electric motors with star-delta starters.

Look at mixers and crushers, as modern controllers can also improve the operating characteristics of a partially loaded motor and reduce shock loads at start-up.

Pneumatic conveyors can combine the functions of conveying and elevating in the same system. They require compressor power and are, therefore, expensive to operate, with air leakage a costly and common problem. In addition, pneumatic conveyors can not be easily adapted to changes in product or throughput.

Selected Publications.

Fluids

GPCS 170	***Variable speed drives in a chemical plant.***
GPCS 222	***Purchasing policy for higher efficiency motors.***
GPCS 300	***Energy savings by reducing the size of a pump impeller.***
GPCS 337	***Low cost speed reduction by changing pulley size.***
GPG 2	***Reducing energy consumption costs of electric motor and drive systems.***
GPG 14	***Retrofitting AC variable speed drives.***

Solids

GPG 212	***Reducing energy costs in flour milling.***

Refer to manufacturer's literature describing electronic motor controllers and previous sections on compressed air and motor drives.

KEY OPPORTUNITIES TO SAVE ENERGY

8. CRUSHING AND GRINDING

Crushing and grinding machinery can be found in a wide range of applications, from limestone crushing to the preparation of powders prior to sale. Much of this plant operates at a very low level of energy efficiency, with up to 99% of the energy supplied to a typical crusher or grinder used to turn the machine when empty.

To optimise the energy used in crushing and grinding, a three-phase approach should be applied:

Phase 1: review existing plant and equipment
Phase 2: compare existing performance with known industry best practice norms
Phase 3: cost the implementation of best practice procedures and apply where appropriate

Optimising crushing and grinding plant can bring a number of other benefits:

- Increased overall plant capacity.
- Increased plant availability.
- Improved environmental performance.
- Stable plant operation.
- Improved production quality.
- Reduced production costs.

Selected Publications.
GPG 181 ***Energy efficient crushing and grinding systems.***

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9. CRYSTALLISATION

Many products are purified and sold in crystal form, and this can be energy intensive.

Two generic designs for crystallisers are available, the evaporative draft tube baffle (DTB), and the Oslo crystalliser, which incorporates a fluidised bed and an external pump to re-circulate fluid. Both crystalliser types have external heaters. For operations requiring high outputs of large crystals, the DTB design will be most commonly used.

ENERGY SAVINGS OPPORTUNITIES

- Examine the potential for recovery of heat from the hot slurry and the vapour flowing from the plant.
- Control systems should also be carefully investigated.
- The selection of the pumping turbine and the scope to retrofit low energy hydrofoil impellers should be investigated because hydrofoil impellers have good flow characteristics and compare favourably with other turbines in terms of both the process and energy efficiency.
- Look at the customer specification for crystal size and quality because the customer may accept less energy intensive products.

APPENDIX 1 - USEFUL CONTACTS

The Environment and Energy Helpline – 0800 585794. *For further information on any of the issues covered in this Guide or help with specific energy efficiency problems at your site, please call the Environment and Energy Helpline on 0800 585794. The Helpline provides free, confidential advice on environmental and energy efficiency issues to businesses in the UK. Smaller businesses may also be able to receive a free, short site visit from an energy or environmental expert.*

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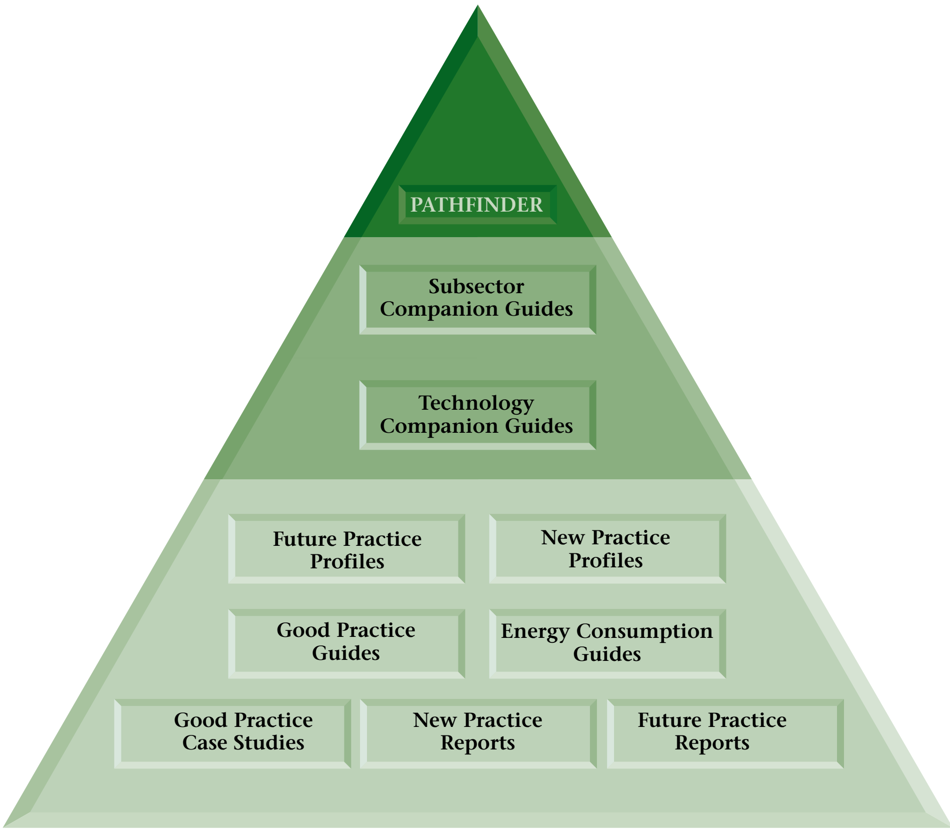

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